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ASSESSMENT OF DRINKING WATER QUALITY IN RURAL AREAS OF SONITPUR DISTRICT (ASSAM), INDIA

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ABSTRACT

The aim of this study is to assess the water quality of ground water in rural areas as the water is extensively used for several purposes of daily use including drinking one. Ground water was collected from rural areas (North-Eastern region) of Tezpur city of Assam (India). The above areas are situated nearby Defence Research Laboratory. The water samples were collected from different consumer ends viz. open wells, bore wells, tube wells etc. for the analysis of physicochemical parameters like pH, Dissolved Oxygen (DO), TDS, Turbidity, Conductivity, Resistivity, Salinity, Iron and Fluoride. pH, turbidity, bacteria and iron of few samples are found to have more than permissible limit (WHO/BIS/USEPA) with DO<4 ppm. Civil population use ground water for drinking purposes and they face health effect due to contaminants present in the water.

KEYWORDS: Ground water, Drinking water, Rural. Iron, Water quality survey

1. INTRODUCTION

Water has a broad impact on all aspects of human life including health, food and energy. The supply of fresh water is essential for the safety of peoples. Every day about 5,000-6,000 children's dies due to water related problems. Presently, more than 0.78 billion people are not getting potable water and succumbs in major health problems. It is estimated that more than one billion people in the world lack access to safe water and within couple of decades the water supply decreases by one-third.

India's fresh water wealth is under threat due to variety of natural and human influences (Singh, 2004). Iron, Arsenic, fluoride and heavy metals occur as minor constituents of ground water in all categories of hydro-geological settings. The high concentration of these minor constituents is of concern as large amount ground water is abstracted by drilling water wells both in rural and urban areas for drinking and irrigation purposes. North East India is full of natural springs and dug wells which are the principal source of freshwater for civil populace. These are economic and easily available source everywhere. There is very poor information available on water quality of North East India. As per literature review, groundwater of Assam is highly contaminated with iron (Aowal et al., 1981). The presence of excess fluoride and endemic of Fluorosis was reported in different district of Assam, excess iron and fluoride is getting detected in more and more areas of the region (Akoijam, 1981; Sushella, 2001)]. Problem of arsenic has also been detected in North Eastern India (Singh, 2004; Singh, 2006).

The main health risks due to arsenic are considered to severe poisoning and carcinogenic, especially, cancer of respiratory system and gastrointestinal tract whereas Iron causes conjunctivitis, choroiditis, and retinitis. Fluoride causes fluorosis, bone disease, it also harms kidneys, nerves and muscles. Similarly, health effects due to high nitrates and heavy metals in water as well as food uptake of animals and humans are equally significant.

Hence, in this study we have carried out analysis of physico-chemical properties of water of North-Eastern region of Tezpur of Assam state in India. This region is considered due to both Tezpur University and DRL Tezpur is nearby Institutes from where much sludge is discarded into ground and water quality may get affected. The water samples were collected from different consumer ends viz. open wells, Bore wells, tube wells and

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CODEN: IJESS7

ponds for the analysis of physicochemical parameters like pH, dissolved oxygen, TDS, turbidity, conductivity, resistivity, salinity, Iron and fluoride.

2. EXPERIMENTAL

The Ground water samples were drawn from different water sources as mentioned in Table 1. A total of 11 samples were collected from eleven different locations (Fig 1A &1B) of North-Eastern part of Tezpur and nearby villages in the month of June 2018. The plastic bottles were thoroughly washed and dried before sample collection. The bottles were rinsed with water sample to be collected at the time of collection. Proper labeling was carried out after collection. During sample collection, the latitude and longitude of the sampling sites along with the water source were recorded [Table 1] using a GPS system (Model: Garmin GPS 72H). Sampling location Map is made by Google earth 6.1 and QGIS 2.12 software (Fig.1).

Table 1: Details of sampling sites and sources of collected water samples

S. No.	Sample code	Water source/ Locality	Latitude (degree)	Longitude (degree)
1.	B1	Well water	26.69038	92.80578
2.	B2	Well water	26.69218	92.82025
3.	B3	Tap water	26.69712	92.83361
4.	B4	Well water	26.69731	92.83354
5.	B5	Boring water	26.69832	92.83291
6.	B6	Well water	26.69582	92.83278
7.	B7	Well water	26.69212	92.84403
8.	B8	Boring water	26.68545	92.84778
9.	B9	Hand pump	26.68876	92.84649
10.	B10	Well water	26.69845	92.83481
11.	B11	Well water	26.69853	92.83256

Table 2: Physico-chemical parameters of collected water samples

Sample code	pH	Conductivity (µs/cm)	TDS (mg/L)	Turbidity (NTU)	Salinity (mg/L)	Total Hardness (mg/l)	D.O. (mg/L)	Resistivity (KΩ)
BIS Standard (desirable-permissible)	6.5-8.5	_	500-2000	1-5	_	200-600	_	1-5
B1	6.61	490.7	468.4	1.35	461.6	175	3.94	1.063
B2	7.10	134.4	128.2	2.28	124.6	50	4.96	3.928
B3	6.94	174.2	166.2	2.86	164.3	75	5.23	3.010
B4	6.76	262.4	251.5	8.70	243.6	125	4.69	1.998
B5	6.27	247.4	235.4	0.17	227.7	87.5	4.58	2.127
B6	6.65	176.4	167.9	1.62	162.5	75	6.46	2.978
B7	6.61	403.6	384.4	0.32	376.3	112.5	7.14	1.300
B8	6.39	208.7	199.8	0.27	193.5	62.5	3.78	2.481
B9	6.45	131.5	125.2	2.38	123.5	50	3.59	3.988
B10	6.28	386.6	368.0	0.55	360.5	150	5.33	1.352
B11	6.35	411.3	392.2	0.71	390.5	125	3.45	1.275

Table 3: Presence of bacteria (Coliform) in different water samples

Sample code	Bacteria Present
B1	No
B2	**Yes**
B3	No
B4	No
B5	No

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B6	**Yes**
B7	**Yes**
B8	No
B9	No
B10	**Yes**
B11	No

Water samples are kept at RT for analysis of physico-chemical parameters as per standard procedures used for water analysis (APHA, 2005) [6]. Samples for bacteria analysis are kept in 4^0C freezers. AR grade reagents, double distilled water and Borosilicate glass wares were used throughout the experiments. pH was determined by digital pH meter (EuTech pH 620). TDS, dissolved oxygen, electrical conductivity, resistivity and salinity were measured by using (Multiparameter EuTech CD 650). Turbidity was determined by using by turbidity meter (EuTech TN 100). Total Hardness was determined by complexometric titration using Erichrome Black-T as an indicator (EDTA method) [Table 2]. Iron was estimated by colorimetric method by using UV-Vis spectrophotometer (Analytic Jena SPECORD 205). Fluoride was estimated with ion meter (Thermoscientific ORION 4 STAR) [Table 3]. Bacteriological test was performed using McCartney culture vial by placing it in incubator for 24 hours [Table 4].

3. RESULTS AND DISCUSSION:

Fig. 1a and Fig. 1b show water sampling area along with co-ordinates (visual photographs 2D & 3D images). The details of coordinates as well as information regarding source are shown in Table 1. All the collected water samples were colorless and odourless.

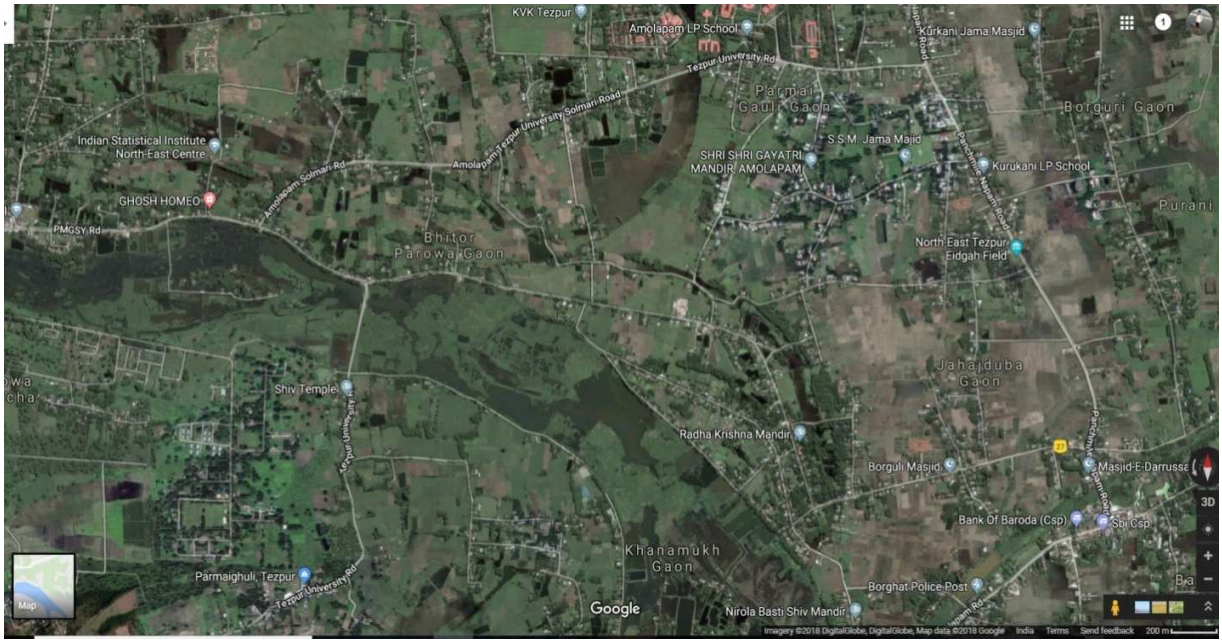

Figure 1a: Location map of water collection points (3D image)

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

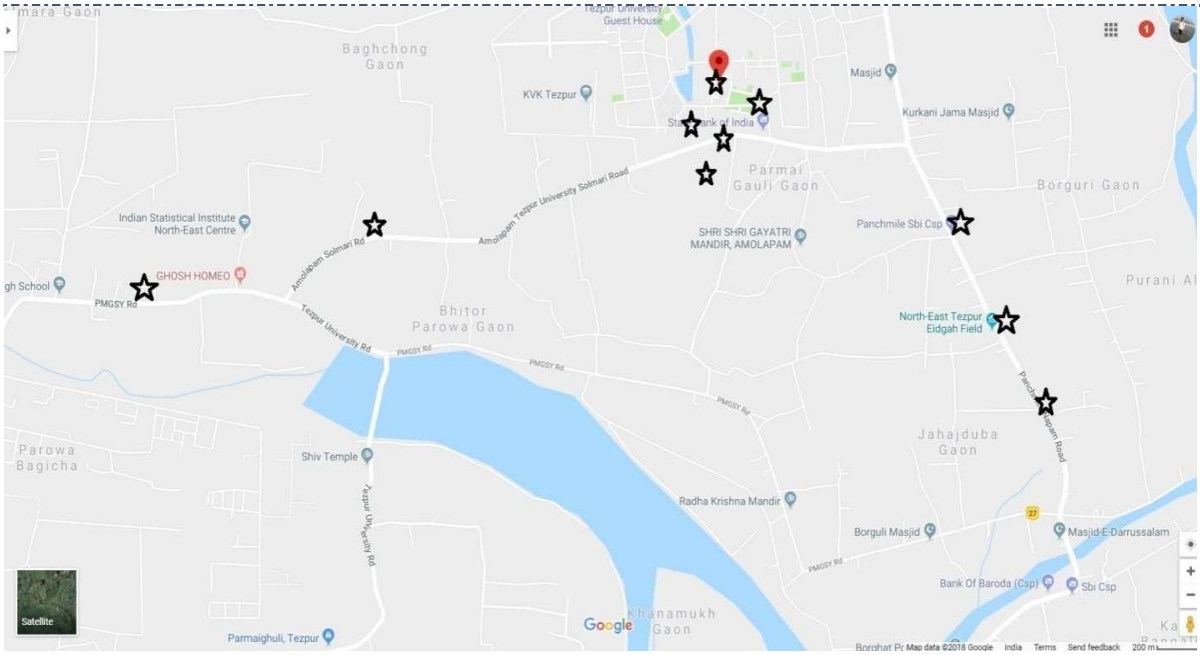

Figure 1b: Location map of water collection points (2D image)

3.1 pH:

The pH of any water body is a measure of its acidic or basic property. It is one of the important parameters in determination of water quality since it affects solubility of various metallic contaminants. Variation in pH of water bodies are related to discharge of industrial contamination or human waste sometimes due to biological activity. The change in pH further leads to changes in physico-chemical parameters of water. Higher pH facilitates generation of trihalomethanes which are defined toxic substances (BIS-10500, 1981). Alkaline pH value is witnessed due to presence of alkaline earth metals (Na, k) that interact with soluble CO forming carbonates and bicarbonates which results in shifting the pH up over 7 (Jena et al.2013). pH is found to be normal for all sources, ranging between 6.27 to 7.10. The sample B2 has the highest value of pH i.e. 7.10 which is in normal range whereas sample B5 has the lowest value of pH i.e. 6.27 which is slightly acidic. According to WHO the normal range for pH in water is between 6.5 to 8.5. Sometimes high pH causes vomiting and muscle twitching.

3.2 Turbidity:

Turbidity is measured by suspended colloidal matter present in solution using light. It may be due to inorganic or organic matter present in solution. High turbidity being an indicator of presence of large amount of suspended solids significantly reduces the aesthetic quality of water source (Verma et al.2012). It increases the cost of water treatment for drinking and food processing. Generally, turbidity causing factors can be either natural or human induced. Human activities can also be cause of erosion. Although the substances resulting in high turbidity may not be intrinsically harmful, but their effects are because turbidity interferes with disinfection during water treatment and provides a medium for microbial growth. In this study, turbidity is measured using Turbidity meter (Eutech Instruments, TN-100). The turbidity of collected water sample is ranges between 0.17 NTU to 8.70 NTU which exceeded the permissible value. This may be due to human activities and presence of suspended particulate matter.

3.3 Total Dissolve Solids (TDS):

It is considered as an indicator of salinity of water and describes all solids dissolved in water. TDS comprise inorganic salts (Ca, Mg, Na, K, HCO_3^-, Cl, and SO_4) and some small amounts of organic matter dissolved in water. TDS can be influenced by changes in pH because it leads to precipitation of some of the solutes as well as affects solubility of suspended matter. Water containing more 500mg/L of TDS is not considered desirable for drinking (BIS-2296, 1982; Shrinivasa Rao and Venkateshwaralu, 2000; Murhekar, 2011). In this study the TDS was measured by Multiparameter Eu Tech Instruments CD 650. The TDS of collected water samples

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

varied from 125.2 mg/L to 468.4 mg/L. All are within permissible limit set by BIS/WHO/USEPA standards. Sample B9 has the minimum value of TDS whereas sample B1 has the maximum value of TDS.

3.4 Electrical Conductivity:
Electrical conductivity is a measure of ability of water to conduct electrical current which provides a general indication of water quality with respect to amount of total dissolved solids such as presence of cations and anions, their concentration and mobility etc. Thus as the concentration of dissolved salts increases, electrical conductivity also increases. Conductivity of water also varies with changes in temperature. In the present study the conductivity of collected water samples is found to be in the range of 131.5µS/cm to 490.7µS/cm. Sample B9 has the minimum value of Electrical conductivity whereas sample B1 has the maximum value of Electrical conductivity.

3.5 Salinity:
Salinity of any water body is correlated to its TDS, since it indicates the presence of dissolved salts. Small amounts of dissolved salts in natural waters are required for the life of aquatic plants and animals but higher quantities lead to severe health issue like increased blood pressure or hypertension leading way to cardiovascular diseases (Mcmichael, 2003). The minimum value of salinity is recorded for the sample B9 i.e. 123.5 mg/L and maximum value of salinity is recorded for the sample B1 i.e. 461.6 mg/L.

3.6 Total Hardness:
Total Hardness is a property of water which prevents lather formation with soap leading to precipitation of soap by forming of complex with cations present in water (Jena et al. 2013) [8]. It is caused due to the presence of cations like Ca^{2+}, Mg^{2+}, Fe^{3+} etc. Total Hardness of collected water samples was observed to be in the range of 50 mg/L to 175 mg/L. Sample B9 and B2 has the minimum value of Total Hardness whereas sample B1 has the maximum value of Total Hardness.

3.7 Fluoride:
Fluoride is required in low concentration by human body to prevent dental diseases but very high concentration of fluoride causes fluorosis which affects the teeth and bones. Moderate amounts lead to dental effect but long term ingestion of large amount of fluoride results in skeletal disorders (Bharti et al. 2017). In the present study, the concentration of fluoride in water samples was observed to be in the range of 0.113 mg/L to 0.382 mg/L. Sample B7 has the minimum value of fluoride concentration i.e. 0.113 mg/L whereas sample B1 has the maximum value of fluoride concentration i.e. 0.382 mg/L. all are within permissible limit.

3.8 Iron:
Iron is an essential element in human nutrition. Estimates of the minimum daily requirement for iron depend on age, sex, physiological status, and iron bioavailability and range from about 10 to 50 mg/day (FAO Food and Nutrition Series, No. 23, 1988). Iron is available in very high amount in ground waters when collected directly from a well. Taste of water is not objectionable at concentrations below 0.3 mg/L, but water with iron concentration above permissible limit become turbid and coloured. In supply water used for drinking purposes, iron deposited as iron(III) hydroxide and rust-colored silt is found at the bottom. In this study iron was estimated by colorimetric method by using UV-Vis spectrophotometer (Analytic Jena SPECORD 205) in water samples iron concentration was observed to be in the range of trace amounts to 1.79 mg/L. The sample B8 and B9 contains iron more than the permissible limit.

3.9 Bacteriological Test:
The coliform groups of organisms originate in the intestinal tract of man and animal. Their presence in drinking water is indicative of potential public hazard, because of the possible presence of pathogenic enteric organisms responsible for diseases such as typhoid, dysentery, cholera etc. The water sample was tested by using McCartney culture vial in which water sample was filled and placed in incubator, after 24 hours some sample turned to black colour which indicates presence of bacteria. The samples B2, B6, B7 and B10 turned black which indicates the presence of bacteria in same (Fig 2).

ISSN: 2277-9655
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CODEN: IJESS7

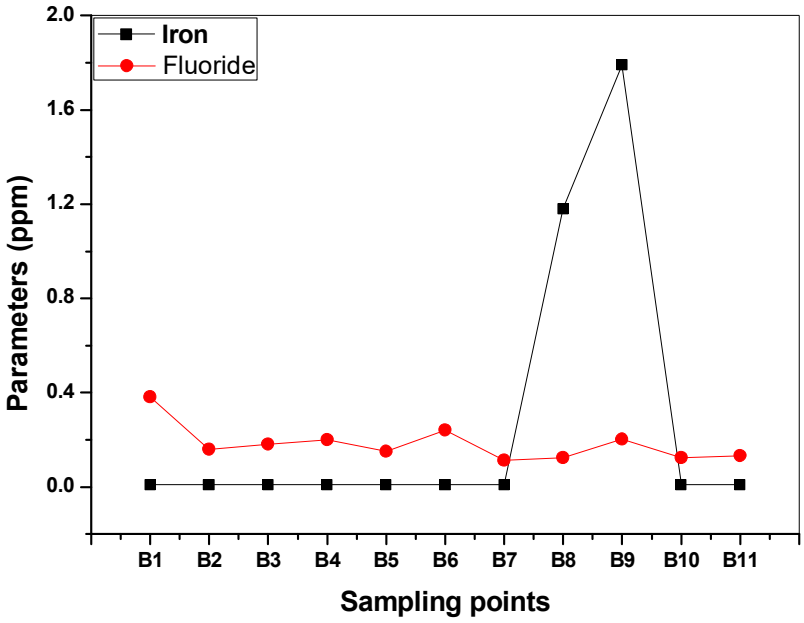

Figure 2: Fluoride and Iron concentration in water collected from different sites

4. CONCLUSIONS

Water throughout the survey area is found to be within permissible limit as prescribed by BIS standard except some samples contain iron, TDS with low pH. Presence of bacteria is also observed in some samples. In some samples iron was found more than the permissible limit. Hence it is recommended that the water should be properly treated for Iron as well as bacteria removal before consumption.

Conflicts of interest

The authors declare that they have no conflict of interest.

Compliance with ethical standards

Research does not involve Human Participants and/or Animals.

Acknowledgment

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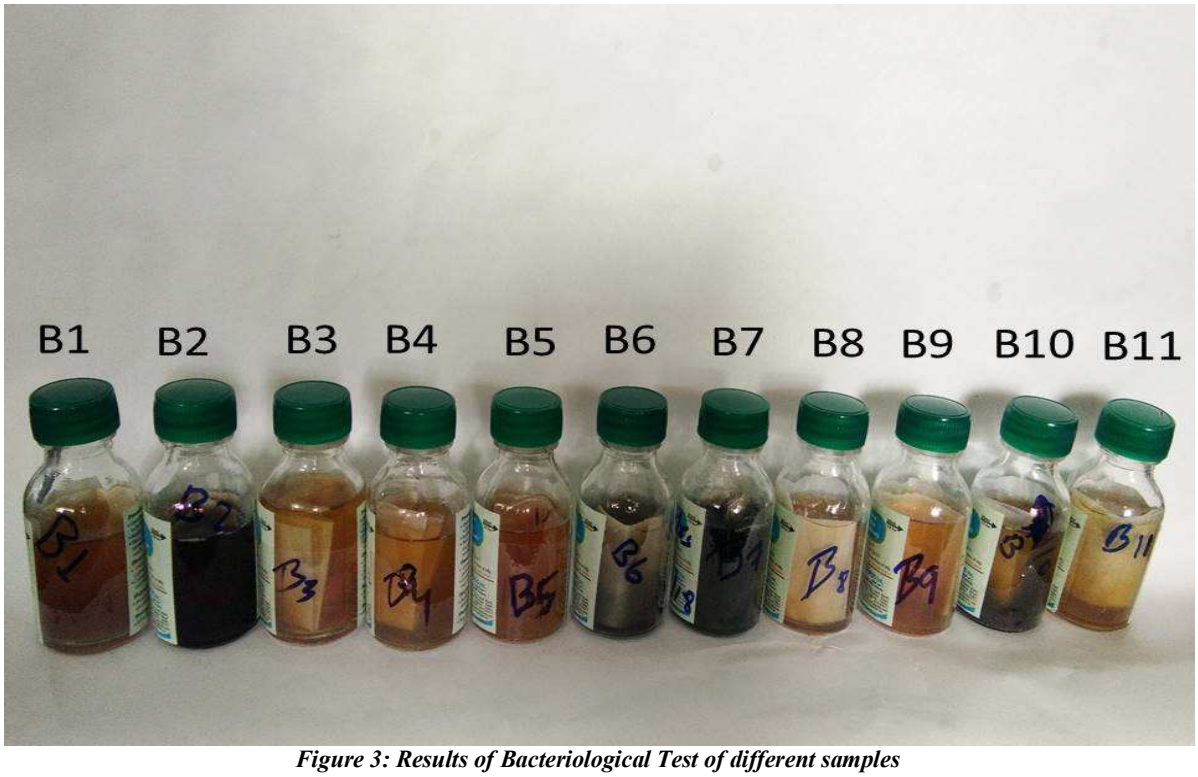

Figure 3: Results of Bacteriological Test of different samples

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

Figure 4a: Water sampling point (Sample B11)

Figure 4b: Water sampling point (Sample B2)

Figure 4c: Water sampling point (Sample B10)

Figure 4d: Water sampling point (Sample B9)
[A primary school]